HR-302 Alternate Method of Bridge Strengthening

Key Words: Bridge Strengthening, Steel Beam Concrete Deck Bridges, Continuous Composite Bridges, Post-

Compression, End restraints, Superimposed Trusses.,

ABSTRACT

The need for upgrading a large number of understrength and obsolete bridges in the United States has been well documented in the literature. Through the performance of several Iowa DOT projects, the concept of strengthening bridges (simple and continuous spans) by post-tensioning has been developed. The purpose of this project was to investigate two additional strengthening alternatives that may be more efficient than post-tensioning in certain situations. The research program for each strengthening scheme included a literature review, laboratory testing of the strengthening scheme, and a finite element analysis of the scheme. For clarity the two strengthening schemes are presented separately in the following paragraphs.

In Part I of this report, the strengthening of existing steel stringers in composite steel-beam concrete deck bridges by providing partial end restraint was shown to be feasible. Various degrees of end restraint were investigated on a full-scale bridge stringer as well as on an existing 1/3 scale bridge model. By varying the amount of restraint, different amounts of strain reduction can be obtained. The finite element analysis developed for verification of the experimental results can be used in determining the degree and location of end restraint required to strengthen a particular bridge.

Part 2 of this report summarizes the research that was undertaken to strengthen the negative moment regions of continuous, composite bridges. Two schemes were investigated: post-compression of stringers and superimposed trusses within the stringers. Both schemes were designed to apply positive moment to the negative moment regions of continuous stringers and thus reduce the stresses resulting from service loads. Each of the strengthening schemes was service load tested on a full-scale mockup of a negative moment region of a bridge stringer. After completion of the service load tests, the full-scale mockup was loaded to failure with the superimposed truss in place. Both schemes were effective in reducing bottom flange stresses; however, the post-compression scheme slightly increased the top flange stresses because of the tension applied to the section. The superimposed truss was very effective in reducing both the top and bottom flange stresses as it applied only positive moment to the mockup. Finite element analysis verified the experimental results; thus, the finite element model developed can be used in the analysis of actual bridges.